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## AN ENGINEER'S OUTLOOK<sup>1</sup>

By Sir ALFRED EWING, K.C.B., F.R.S.

LET me make a confession which may also serve as an apology. I have the unwelcome distinction of being the oldest president the association has ever suffered. In its primitive years the average age of presidents scarcely exceeded fifty: one of them, aged only twenty-nine, afterwards founded the Cavendish Laboratory, and so did a service to science which it would be impossible to overvalue. As time went on the choice fell on older men, and now the electors have taken what one hopes may be regarded as an extreme step. But, as it happens, this is not the first time I have read the president's address. At the Edinburgh meeting of 1921 the president, Sir Edward Thorpe, was prostrated by illness and asked me to act as his mouthpiece. The small service so rendered brought an unexpected reward. Some newspaper report must have confused the platform substitute with the real president, for a well-known novelist sent me a copy

<sup>1</sup> From the address of the president of the British Association for the Advancement of Science, York, 1932.

of one of her romances, which was no doubt meant as a tribute to Sir Edward. It was called "The Mighty Atom"—an arresting title. Perhaps that is why I did not read beyond the title-page. Without close examination it was put by a more orderly hand than mine on a shelf that already held works on like subjects by authors such as J. J. Thomson and Rutherford and Bohr. "The Mighty Atom" was said to be one of the best sellers of its day: in that respect, if in no other, it found congenial company when it was joined on the same shelf by a series of volumes from the fascinating pens of Eddington and Jeans. These, however, I need not tell you I have read and reread, to my entire pleasure and partial understanding.

If "The Mighty Atom" was an arresting phrase, it was also an apt one. For we now know the atom to be indeed mighty in senses that were little suspected by the begetters of atomic theory. It has been mighty in sweeping away ideas that were found inadequate, in demanding fresh concepts, in presenting a new

world for conjecture and experiment and inference, in fusing chemistry and physics into a single science. It is found to be mighty in the complexity of its structure and the variety of radiations it may give out when excited to activity. It has unravelled for us the bewildering tangle of spectroscopic lines. And, most surprising of all, the atom, however seemingly inert, is mighty in being a magazine of energy which, for the most part, it locks safely away. This is fortunate, for if the secret were discovered of letting loose the atomic store we should invite dissolution at the hands of any fool or knave. And it is also fortunate that in the furnace of the sun, at temperatures far higher than those of our hottest terrestrial infernos, the stored energy of the atom is drawn upon, as we believe, and has been drawn upon for ages, to keep up that blessed radiation which makes man's life possible and is the source of all his power.

In the middle nineties there set in an astonishing renaissance of physical science which has centered in the study of the atom and extends by inevitable logic to the stars. In quick succession came three great discoveries: the x-rays by Röntgen in 1895; radioactivity by Becquerel in 1896, and the electron by J. J. Thomson in 1897. Sensational, puzzling, upsetting, these events inspired every physicist to new activities of thought and equipped every laboratory with no less novel methods of research. A flood of further discovery followed, the flow of which continues unabated. Within the last few months notable items have been announced that well deserve our attention. It may not be inappropriate if I try for a few minutes to touch—however lightly—on one or two aspects of this subject, as it is seen through the eyes of an engineer.

Thanks mainly to J. J. Thomson, Rutherford and Bohr, we now recognize the atom of any substance to be a highly complex structure, built up, so to speak, of two sorts of blocks or brickbats—the electrons, which are indivisible units of negative electricity, and the protons, which are indivisible units of positive electricity. It is strangely simple to be taken back, as it were, to the nursery floor and the childish game, and given just two sorts of blocks, exactly alike in each sort, and exactly the same number of each sort, with which to build the universe of material things. The blocks are unbreakable: we can not produce them or destroy them or change them. In respect of electrical quality the two kinds are equal and opposite, but they contribute very unequally to the atom's mass, each proton (for some reason not yet understood) contributing about 1,840 times more than each electron. Every substance is made up of blocks of the same two sorts. If you compare different substances you find that the diversity of their chemical and other proper-

ties arises solely from differences in the number and arrangement of the blocks which compose their atoms. Any atom, in its normal or electrically neutral state, must contain an equal number of protons and electrons. All the protons in any atom are gathered close together at the center, along with some of the electrons, forming a compact, dense portion which is called the nucleus. Although the nucleus accounts for nearly the whole of the atom's mass, it occupies no more than a very minute fraction of the atom's volume. Those of the electrons which are within the nucleus doubtless serve to bind the protons together; the other electrons constitute, as it were, a voluminous crinoline, or rather a series of crinolines, extending relatively far away from the center and giving the whole atom an exceedingly open structure. Within that open structure upheavals may be caused by outside agents in various ways. One or more of the electrons in the crinoline may be temporarily removed (as, for instance, by the action of heat or by the incidence of energetic radiation), and the atom is then said to be ionized: for a time the balance between positive and negative is upset. But the missing electron returns to its place, or another comes instead, and when this happens a definite amount of radiation is given out, much as energy is given out when a weight falls from one to another landing of a staircase. We may speak of the landings as energy levels. The radiation which issues when an electron falls from one energy level to another constitutes what is called a photon.<sup>2</sup> It has two aspects, behaving in one like a particle and in the other like a group of waves, and at present we have to accept both, though we can not fully reconcile them. The photon carries a definite quantity of energy and is characterized by a definite frequency of vibration. Its energy depends on the two levels between which the electron falls, and this determines the frequency of the vibration which the photon conveys, for the frequency is equal to the energy divided by that mysterious constant of nature, the quantum of action discovered by Planck. In any element all the atoms have the same set of energy levels: these contribute to the emission spectrum and account for its groups of spectral lines. In heavy atoms there are many energy levels, and consequently very many lines appear in their spectra.

I will not weary you with details that are now fairly familiar. What we have to realize is that all matter consists of the two kinds of electricity, protons and electrons, held apart we do not know how. To the early experimentalists who electrified rods of resin or glass by rubbing them, electricity seemed no more

<sup>2</sup> We owe the name "photon" to Professor G. N. Lewis, of Berkeley, California, who proposed it in a letter published in *Nature* of December 18, 1926.

than a curious attribute of matter: now we regard it as matter's very essence—the ultimate stuff out of which every atom is built. If you ask, What is electricity? there is no answer, save that it is a thing which exists in units of two sorts, positive and negative, with a strong attraction for each other, and that in any atom you find them somehow held apart against that attraction, with a consequent storing of potential energy. They are prevented from coalescing, although the difference of potential between them is nearly a thousand million volts. Why they do not flash together is a mystery—one of the many mysteries which physicists have still to solve.

Engineers are accustomed to the idea of storing energy in a condenser by charging the opposed plates to a potential of a few scores or hundreds or thousands of volts. That is done by transferring some of the crinoline electrons from one to the other plate: it involves only a minute supplementary separation, which disappears when the condenser is discharged. In every atom we have a permanent separation of electricities; the protons and electrons look at one another, so to speak, across an immensely greater dielectric gulf which no laboratory operation ever causes them to bridge. That is why every atom is a magazine of energy, the quantity of which ( $mc^2$ ) is proportional to the atom's mass.

Any of the usual operations of the electrical engineer, such as charging and discharging a condenser or a storage battery, or driving a dynamo and conducting electricity from it to a distant station where it can actuate a motor or heat the filaments of lamps to incandescence, may be described as the setting up and the breaking down of a comparatively small extra difference of potential between the opposed electricities in some of the atoms of the engineering plant. In every process of industrial electricity, on whatever scale, what happens is a temporary enlargement of the potential difference which always exists between electrons and protons, and then a return to what may be called nature's *status quo*. But those supplementary differences of potential which the engineer first superimposes and then allows to disappear are exceedingly small, even at their greatest, in comparison with the gigantic difference which the normal condition of the atom itself involves.

A notable event of the year is the strong evidence which Dr. Chadwick, of the Cavendish Laboratory, has found for the existence of what is called the neutron—a type of particle in which an electron and a proton are associated in particularly close juxtaposition. There is a like close association between electrons and protons in the nucleus of any heavy element, but it had not previously been discovered in a single isolated pair. Twelve years ago Lord

Rutherford conjectured the existence of such a particle and described the properties it should possess. Its excessive smallness and density, together with its lack of an external electric field, give it a unique power of penetrating matter. It is too slim to be confined under pressure in any vessel: it will simply slip through the walls. The normal hydrogen atom has the same two constituents, one proton and one electron, but in nothing like the same intimacy of association, for the hydrogen atom wears its electron as a bulky crinoline which confers on it an immensely greater volume. The neutron, on the other hand, may be said to have taken the crinoline off, folded it up and put it in its pocket. Not to be too fanciful, we may at least describe the partners as clasping one another so tightly that the electron has ceased to be a fender; none the less as a unit of negative electricity it still serves to give electrical balance to the pair. Though so close together, the two constituents of the neutron remain separate and distinct, parted by nearly as many million volts as in a hydrogen atom. In this hitherto unknown particle, whose existence the experiments of Dr. Chadwick seem to have definitely proved, we have a new physical entity of extraordinary interest and a powerful tool for further research.

Lord Rutherford was the first to discover and name the nucleus. It is the inner sanctuary of the atom, the repository of secrets many of which have yet to be disclosed, almost unapproachable, not only because of its smallness but because of the electric field in which it is encased. Recognizing the nucleus to be a richly charged strong-room, Rutherford has spared no effort to break it open. He has submitted it to a furious bombardment, using as missiles the alpha particles which radioactive substances project. These particles, each consisting of four protons and two electrons compactly built together, have the necessary velocity and energy to penetrate to the atom's heart. Rutherford had perforce to fire into the brown: he could not aim his gun, nor even tell when it would go off: the chances of a hit were no more than one in many millions. But hits were in fact obtained—hits so effective that they chipped off protons and caused the missile to be absorbed, thus realizing the dream of the alchemist by making one element change into another. That was a dozen or more years ago: since then his attack has lost none of its severity. It has been taken up under his guidance by a school of workers and many further secrets of the nucleus have been revealed.

Quite recently two of his disciples have gone one better, as disciples sometimes do, to the joy of their lords. Dr. Cockcroft and Dr. Walton have used missiles of their own making, instead of those that

come spontaneously and intermittently from substances such as radium or thorium. By beautiful devices they have applied their knowledge of electrical engineering and their mastery of electrical technique to project single protons into the nucleus of lithium, using a steady potential of several hundred thousand volts to give the projectile sufficient penetrating power. An atom of lithium has (usually) seven protons and four electrons in its nucleus; the other three electrons constitute the crinoline. Here again it was a case of firing into the brown—out of millions of shots a few reached their billet. When the projected proton forces an entry into the lithium nucleus it creates a domestic disturbance of the liveliest kind. For with the seven protons already in occupation it makes an eighth; the group then splits into two sets of four, each taking two of the electrons, and they fly violently apart with an energy drawn from the atomic magazine. The result is that two helium atoms are formed. This is a notable achievement, the first artificial splitting of the atom by a laboratory process in which there is no recourse to the violent projectiles which radioactive substances provide. It has been followed up by successfully applying the same method to break up the atoms of other elements.

It is a satisfaction to learn that in all the encounters and emissions and absorptions that are studied among atoms and photons and the parts of atoms there is, so far as we yet know, strict compliance with the accepted principles of conservation in respect of momentum and energy and mass, though matter (in the ordinary sense) is liable to transformation into energy and energy into matter. When radiation is emitted some matter disappears, for the atom that emits it loses a little of its mass; when radiation is absorbed a like quantity of matter comes into being.

But the engineer finds himself obliged to admit that no mechanical model of the atom can be expected to give an adequate picture of that strange new world. Our mechanical ideas are derived from the study of gross matter, which is made up of vast aggregates of atoms, and any model must share the limitations this implies. It is futile to explain the constitution of the atom in terms applicable to gross matter, just as it would be futile to study the psychology of an individual by observing only the movements of crowds. So we must expect to find within the atom and among its parts qualities and actions different in kind from those we know, and paradoxes which without a wider vision we can not interpret. Such a paradox indeed confronts us at the present time, when we try to harmonize the wave aspect and the particle aspect of the photon, of the electron, and indeed of matter itself. These things are still a mys-

tery—a riddle which some day we may learn to read. Meanwhile we do well to remember that any attempt to portray the structure of the atom in the language of ordinary experience is to give undue significance to symbols and analogies that are more or less invalid. Qualifying phrases like "so to speak" or "as it were" can not be escaped. They are confessions that the image is inevitably a distortion of the reality it is intended to suggest.

Let us now glance back to the early days of the association, and trace a little—a very little—of what it has done for the advancement of science, both pure and applied. The two inevitably march together. Between discovery and invention there is, in effect if not always in form, a close partnership with a constant interchange of advantage. No discovery, however abstract, is safe from being turned to practical account; on the other hand, few if any applications fail to react in stimulating discovery and providing the experimentalist with more effective weapons of attack.

From the first the association took cognizance of engineering as one of the subjects it was created to advance. One of its earliest acts, and a very wise one, was to invite reports on the state of science: these were called for in many different fields and were written by the best available experts. In the first batch of such reports were two that dealt with engineering, one on the strength of materials and the other on hydraulics. As it happened, they were of very unequal merit; but they are alike in this, that they demonstrate how conspicuous was the lack of science on the part of early British engineers.

The engineers of those days were big professional figures. They had covered the country with a network of roads and bridges and canals; they had drained the fens; they had built harbors and light-houses. By multiplying factories, by extending the uses of coal and iron, they were laying the foundations of that commercial supremacy which, so long as it lasted, we took for granted as a sort of national right. They had taught the world how to light towns by gas, and were beginning to drive ships by steam. Above all, they had shown that a new era of locomotion was about to set in. A railway connecting Liverpool with Manchester had been opened: its success was proved, and schemes were projected that would soon utilize labor on a large scale for a host of tunnels and cuttings and embankments, and so relieve the scourge of unemployment which—as we also know—follows the scourge of war. The engineering pioneers were sagacious men who put their faith in experience; they knew little of theory and cared less. Instinct and personality carried them through difficulties of a kind that science might have helped them

to solve or to avoid. They had the sense to profit by their own mistakes.

It is significant that in 1832, when the British Association called for a report on the present state of our knowledge of hydraulics as a branch of engineering, the terms of reference included this curious phrase: "Stating whether it appears from the writings of Dutch, Italian and other authors that any general principles are established in this subject."

The report was written by George Rennie, a son of the greater Rennie, who left us a monument of his genius—I wish I could say an imperishable monument—in Waterloo Bridge. After giving a good summary of the work of foreign theorists the reporter remarks:

It only remains for us to notice the scanty contributions of our own countrymen. While France and Germany were rapidly advancing upon the traces of Italy, England remained an inactive spectator of their progress.

It is clear that there was much need for the scientific leaven which the new association could, and did, provide.

Another of the early concerns of the association was with the performance of steam engines. At the date of our foundation more than fifty years had passed since the inventions of Watt provided an engine fit to serve as a general means of producing power. Its earliest application, and still at that date its most common one, was in the pumping of mines. Engineers took a professional and even sporting interest in what they called its "duty," meaning the amount of water pumped through a given height for each bushel of coal consumed. Nevertheless, it is a remarkable fact that neither they nor the physicists of that period had any notion that the process involved a conversion of heat into mechanical work. It is difficult for us now to imagine a world of physics and engineering where the idea had not yet dawned that there was such a thing as energy, capable of Protean transformations, but in all of them conserving its total amount. Enlightenment was soon to come, and our meeting-rooms furnished the scene. In 1843 Joule brought before one of the sections his first determination of the mechanical equivalent of heat. He spoke with the modesty natural—in those days—to a man of twenty-four. His paper was received in chilly silence. Two years later, after further experiments he reappeared; but again no notice was taken of the heresies of a youthful amateur. Nothing daunted, he prepared a fuller case for the Oxford meeting of 1847, perhaps remembering that Oxford is the home of lost causes. In a narrative written many years later, Joule has told how the

chairman suggested that as the business of the section pressed he should not read the paper, but merely give a brief account of his experiments:

This [he says] I endeavoured to do, and discussion not being invited, the communication would have passed without comment if a young man had not risen in the Section and by his intelligent observations created a lively interest in the new theory. The young man was William Thomson.

But Thomson, though deeply interested, was not at first convinced. Nearly four years more were to pass before he satisfied himself that the doctrines of Joule did not clash with the teachings of Carnot, of which he was then an enthusiastic proselyte. At length he became a convert; he saw, as we should now say, that the first law of thermodynamics was in fact consistent with the second. Then indeed he accepted the principles of Joule in their entirety and was eager in their support. Quickly he proceeded to apply them to every part of the physical domain. Along with Clausius and Rankine he formulated the principles which govern the whole art of producing power by the agency of heat. The steam turbine of Parsons, the gas engines of Otto and Dugald Clerk, the oil engines of Daimler and Diesel, with all their social consequences in making swift travel easy by road and possible by air, are among the practical results. On the same thermodynamic foundation was built the converse art of mechanically producing cold, which we employ in ever-increasing measure for the import and storage of our food. Joint experiments undertaken by Joule and Thomson led to a further discovery which later enabled the process of refrigeration to be carried very near to the limit of coldness which Thomson himself established as the absolute zero. In the hands of Linde and Claude the "Joule-Thomson effect" as a means of producing extreme cold has created new industries through the liquefaction of air and the separation of its constituents by methods of fractional distillation. However cold, however near the absolute zero, was the association's first reception of Joule, we may claim that in effecting a conjunction between him and Thomson it made amends. Their meeting in 1847 ushered in a new era both of scientific theory and of engineering practice.

Of the association's many other services there is little time to speak. When the telegraph developed in the middle of last century and spread itself across the Atlantic, largely under the guidance of that same William Thomson (whom later we knew as Lord Kelvin), there were no accepted units in which electrical quantities could be measured and specified.

The scientific world was as badly off then for a standard of electricity as the commercial world is now for a standard of value. The need of electrical standards was urgently felt, by none more than Thomson himself. He stirred the association to act: a strong committee was set up, and in time its work served as a basis of international agreement. There is no danger that any country will wish to "go off" the standards thus established. To settle them was an incalculable boon to science no less than to technics. It paved the way for the revolution of the eighteenthies, when electricity passed, almost suddenly, from being no more than the servant of the telegraph to be master of a great domain. It was then that the electric light and the electric transmission of power gave it a vastly extended application, and the fundamental discoveries of Faraday, the centenary of which we lately celebrated, came into the kingdom for which they had waited nearly fifty years.

Another notable achievement of the association was to promote the establishment of a National Physical Laboratory. Informal talks at our meetings in the nineties led to the appointment of a committee which moved the government of the day to take action. The laboratory was constituted, and Sir Richard Glazebrook was appointed its first head. What it has become in his hands and the hands of his successor, Sir Joseph Petavel, does not need to be told. From small beginnings it has grown to be an influential factor in the world's scientific progress, and a legitimate subject of national pride.

Another by-product of quite a different sort is the memorial to Charles Darwin which we hold as trustee of the nation and of all nations. At our meeting in 1927 the president, Sir Arthur Keith, spoke in his address of the house where Darwin lived and worked, pointing out how admirably it would serve as a monument to the great naturalist. No sooner was the suggestion published than a donor came forward whose devotion to the memory of Darwin expressed itself in a noble gift. Sir Buckston Browne not only bought and endowed Down House, but arranged with pious care that the house and its grounds should exhibit, so far as was possible, the exact environment of Darwin's life. The pilgrims who now visit this shrine in their thousands see Darwin's study as it was when the master thought and wrote, and can reconstruct the habit of his days. There could not be a more appropriate memorial. Its custody by the association involves obligations which are by no means small, and we may claim that they are worthily fulfilled.

One may safely say that there is no department of scientific endeavor our meetings have not aided,

no important step in the procession of discovery they have not chronicled. It was at our meeting of 1856 that Bessemer first announced his process of making a new material—what we now call mild steel—by blowing air through melted pig iron. Produced in that way, or by the later method of the regenerative furnace and the open hearth, it soon revolutionized the construction of railways, bridges, boilers, ships and machinery of all sorts, and it now supplies the architect with skeletons which he clothes with brick and stone and concrete. It was at the Oxford meeting of 1894 that Lodge demonstrated a primitive form of wireless telegraph based on the experiments of Hertz, a precursor of the devices that were brought into use a little later through the practical skill and indefatigable enterprise of Marconi. At the same meeting there was an epoch-making announcement by the late Lord Rayleigh. His patient weighings of the residual gas which was found after depriving air of all its oxygen led him to the discovery of argon. That was a surprise of the first magnitude; it was the herald, one may say, of the new physics. Next year his colleague Ramsay presented other members of the family of inert gases. It is curious to recall the indifference and scepticism with which these really great discoveries were received. Some of the chemists of that day seem to have had no use for inert gases. But the stones which the builders were at first disposed to refuse have become head stones of the corner. In the architecture of the elements they fill places that are distinctive and all-important; they mark the systematic sequences of the periodic law. In a metaphor appropriate to atomic physics we may describe them as coy ladies with a particular symmetry in their crinoline of electrons, unresponsive to advances which other atoms are ready to make or to receive. Inert though they be, they have found industrial uses. Helium fills airships; argon fills incandescent lamps; and neon, so modest a constituent of the atmosphere that you might think it born to blush unseen, has lately taken to blushing deliberately and even ostentatiously in the shop-signs of every city street. In the field of pure science it was neon, outside the radioactive elements, that first introduced us to isotopes. And helium has a greater glory as the key to radioactive transformations and historian of the rocks. Disciples of evolution should be grateful to helium for delivering them from the cramping limits of geological time which an earlier physics had mistakenly imposed.

My own recollection covers many surprises that are become commonplaces to-day: the dynamo, the electric motor, the transformer, the rectifier, the storage battery, the incandescent lamp, the phonograph,

the telephone, the internal combustion engine, aircraft, the steam turbine, the special steels and alloys which metallurgists invent for every particular need, wireless telegraphy, the thermionic valve as receiver, as amplifier, as generator of electric waves. To that last we owe the miracle of broadcasting. Who, a generation ago, would have imagined that a few yards of stretched wire outside the window and a magic box upon the sill should conjure from adjacent space the strains of Beethoven or Bach, the exhortations of many platforms, the pessimism natural to those who forecast the weather and the optimism of orators who have newly dined?

Sounds and sweet airs, that give delight and hurt not. Sometimes a thousand twangling instruments . . .

And sometimes voices . . . that, when I waked, I cried to dream again.

I don't know any product of engineering more effi-

cient than that magic box. It needs no attention; it is always ready for service; and when you tire of it you have only to switch it off. A blessing on it for that! Heard melodies may be sweet, but those unheard are often sweeter. Do you ever reflect, when you pick and choose among the multitude of airs and voices, or shut out all from your solitude of thought, that they are still there, physically present, individual, distinct, crowding yet not interfering, besetting you though you do not perceive them, silent until you determine that one or another shall catch your ear? Go where you will, to the ocean or the wilderness or the pole, you can not escape that vast company of attendants; they come to you, unheard, unseen, from every quarter of the globe with a swiftness no other messengers approach. Is any fairy tale so strange as that reality? In all the wizardry of science surely there is nothing more wonderful than this.

## THE NEW HYDROBIOLOGICAL LABORATORY ON THE CHESAPEAKE<sup>1</sup>

By Professor JAMES G. NEEDHAM  
CORNELL UNIVERSITY

I BRING you the congratulations of the hydrobiological fraternity. This is a fine laboratory in a wonderful environment, with live problems at its very door. It is an undertaking of great promise. It brings research facilities to the problems. In laboratories remote from the sources of experimental materials, far too much work is done with a few weazened specimens and under conditions that put a strain on their very existence. Here one may work in the midst of all the wealth of nature, and may know that he is dealing with natural conditions. Here the training of the university laboratories and the facilities of the field may come together, and practical problems may be met in a practical way.

Here are vast natural resources, and we know right well that there are difficulties in their management. It is time to stop guessing as to what should be done, and time to start fact-finding with adequate facilities. More knowledge is needed. Understanding leads to control.

We marvel to-day at the changes that have come over human affairs in our own time. Science seems to be transforming the world and the rate of its progress is ever accelerating. And why? Is it not because society has become aware of its own intellectual resources and has begun developing them, first, by offering encouragement to invention, and, latterly, by offering encouragement to research? Invention is

encouraged by the instrumentality of the patent office; research by the experiment stations and by laboratories such as this one. Science began to make the world over when it became cumulative; when observers began to preserve detailed records of observations and experiments; when its problems were analyzed and split into manageable parts and tackled one at a time; when it organized cooperation and provided for comparison and criticism of results and put these results into economic use.

The spirit of inquiry into the processes of nature lies at the root of all human progress. Scientific curiosity has been called "the divine instinct." It sets us apart from all other creatures. We seek to know. Of all creatures living on the earth, we of the human species are the most inquisitive. We share with animals certain states of mind—joy, fear, anger, curiosity, etc.—and manifest them by like behavior. We probably do not get more frightened or more angry than some other creatures, but we are far more curious to know about things. Therein lies a difference that in its cumulative results sets us so far apart from other living things as to make us seem like another order of things. This desire to know is responsible for the development of all our science.

It is a great pleasure to come to this beautiful spot and to share in these exercises at the founding of a biological laboratory in a place where life does so abound, and where every turn invites to its pleasurable contemplation. How bountiful nature is

<sup>1</sup> Remarks at the dedication of the Biological Laboratory on Solomon's Island, Maryland, July 19, 1932.

toward the waterside! What an astonishing abundance and variety of both plant and animal life she bestows there! We have been too long content to say, "What a pity that so little of it is of any use to us!" But how much of the wild life of the upland is of any use to us? If we have found out how to manage in our own interest the products of the upland field, and have no water gardens, that is our own fault and not nature's. Earth yields her increase quite impartially. We have studied intensively the problems of the land, and only haphazardly those of the water.

Agriculture has its experiment stations in every state in the Union, doing for the crops of the land what ought next to be done for crops of the water. Valuable aquatic animals should be studied, as land animals have been, until we know every detail concerning their food, their enemies, both predatory and parasitic, their times and seasons, and the conditions that make for their increase. This means research—sustained research, which is the work for patient investigators. It will for the most part be done by men working alone, for nature does not yield up her secrets to a crowd, or even to a committee, but only to her humble and watchful devotee. After a discovery of a fundamental nature has been made, then cooperation is needed to learn the limits of its application. Life is a complex of changing factors, and environment is a complex of unstable conditions.

A good method is a good method only locally and under certain conditions. It needs to be tried out, zone by zone, and province by province; and the co-operation of many hands in many places is often needed to find its limitations and its true economic value. Field laboratories like this should be maintained, if not in every state, at least in every principal region of North America, for the study of aquatic biology and for the development of a real aquiculture.

This laboratory will be of service to the great coastal region of the eastern United States, but it will especially serve Maryland; for the problems of the Chesapeake, due to conditions peculiar to the Chesapeake, can be studied best in the Chesapeake. The State of Maryland is to be congratulated on this enterprise. It is well conceived for the betterment of her vast aquatic resources. Here she provides facilities for research, for fact-finding, concerning these resources. It is quite safe to predict that this will prove to be one of her best investments.

It is altogether appropriate that this laboratory should be located here, near where that great American zoologist, William Keith Brooks, made his pioneer investigations and prepared his monumental work on the oyster. It starts with the goodly tradition of his excellent work. It will be well if this laboratory can retain his interest both in pure science and in its applications to human welfare.

## OBITUARY

### CARL LEO MEES

DR. MEES, who died on April 20, 1932, was born in Columbus, Ohio, on May 20, 1853, son of the Rev. Konrad and Elise (Adam) Mees. His father was a native of Germany and came to this country when a young man, settling first in New York and later going to Columbus, where he served one congregation for over 50 years.

Dr. Mees' early education was received from private instructors. At the age of about 11 years he entered the eighth grade of the public school and was graduated from the Columbus High School in 1869. While a student in high school he acted as assistant to Dr. Thomas C. Mendenhall, his instructor in physics, and from him received the inspiration which led him to specialize in physics and chemistry.

After completing his high-school work, Dr. Mees entered Starling Medical College in 1870, and in 1871 became assistant to Dr. Thomas G. Wormley, at that time one of the greatest authorities in the world on poisons and the foremost chemist in legal expert work in the United States. Dr. Mees' work was along the line of perfecting the methods of the detection and

identification of human blood and tissues in suspected murder cases.

In the course of this work he devised and perfected a method of microscopic identification which was accepted throughout the profession. He was the first to succeed in photographing different kinds of blood for comparison and exhibition to juries. This work was standardized and accepted in the United States army and navy museum. Some 100,000 blood measurements were made by this method.

Dr. Mees took the medical course in Starling Medical College parallel with his work in chemistry and received his degree in medicine in 1875. However, he never practiced medicine. The two following years were spent in the Ohio State University, then known as the Ohio Agricultural and Mechanical College, where he devoted his time to the study of physics under Dr. Mendenhall. During this period he continued to act as assistant to Dr. Wormley and gave lectures upon the microscope in Starling Medical College and upon chemical laboratory practice in Columbus Medical College.

In 1875, Dr. Mees was elected professor of physics

and chemistry in the University of Louisville, now known as the Louisville Male High School. In 1880, he resigned his teaching position and went abroad for study. He spent some time in the University of Berlin under Helmholtz, Kirchhoff and Hoffmann; also in South Kensington under Professor Frankland and in London under Dr. Tyndall.

In 1882, he was called to the professorship in physics and chemistry at the newly organized Ohio University in Athens, remaining in that position until 1887.

In September, 1887, Dr. Mees was called to the position of assistant professor of physics under Dr. T. C. Mendenhall, who had just previously become

president and professor of physics at Rose Polytechnic Institute, Terre Haute, Indiana. In 1889 he was made professor of physics. After the resignation of Dr. Mendenhall in 1890, he acted as chairman of the faculty until Dr. Eddy assumed the presidency in 1891. He was made acting president in 1894 and elected president in 1895, in which position he served until his resignation in September, 1919, when he was made president emeritus.

Dr. Mees was general secretary of the American Association for the Advancement of Science in 1889, secretary of Section B of the same, 1888, president of Section B, 1896, and president of Section E in 1920.

JOHN B. PEDDLE

## SCIENTIFIC EVENTS

### SURVEY OF THE INDIAN OCEAN

ARRANGEMENTS are being made to send an oceanographical expedition to the Arabian Sea and North-West Indian Ocean next year. Funds for the expedition, according to a correspondent of the *London Times*, have been provided by the trustees of the late Sir John Murray, F.R.S., of the Challenger Expedition, 1872-76, from certain moneys set apart by him in his will, and a committee, including Dr. Allen, of Plymouth Marine Station, Admiral Douglas, the hydrographer of the Navy, and representatives of the Royal Society and the Natural History Museum, has been formed under the chairmanship of J. C. Murray, with J. Stanley Gardiner, professor of zoology at the University of Cambridge, as secretary.

The Indian Ocean was chosen for the expedition after a set of questions had been sent to the leading oceanographers of all countries. It was pointed out that Sir John Murray had always regarded the survey by the Challenger Expedition of the oceans of the world as incomplete owing to the omission of the Indian Ocean. The work in this ocean was to have been provided for by the Indian Government, and was under consideration when the war broke out in 1914, since when financial conditions have made it impossible. Only one out of the many subsequent deep-sea expeditions—namely, that of the German *Valdivia*—had traversed the Indian Ocean, though the islands and their banks and slopes had been investigated in 1905 by H.M.S. *Sea Lark*. These enclose an area of a general depth of 2,500 fathoms, the Arabian Sea, in which there are few soundings save on the direct steamship lines from Aden to Bombay and to Colombo. The collections of deposits from the floor of this sea are relatively fewer than in any other region, as shown in the great Murray collection of deep-sea deposits in the British Museum. Their

peculiar variation has been held to indicate recent subsidences of the ocean floor, which is also an area of great chemical changes. The south coast of Arabia is peculiarly bare of coral reefs, and this indicates unfavorable conditions for shallow-living animals, which require investigation, while the deeper-living animals of the same region are practically unknown.

The expedition will be under the leadership of Colonel Seymour Sewell, director of the Indian Museum at Calcutta, and will leave in August, 1933, to work throughout the Northwest monsoon, returning in April, 1934. The Arabian Sea will be traversed on several lines between Africa and India, and special investigations will be made of the Gulfs of Omar and Aden, leading respectively to the Persian and Red Seas.

The main objects for investigation by the expedition will be the topography of the ocean bottom by echo soundings, to discover whether there are any traces of the continental land areas that are supposed to have stretched westwards from India and to have formed the hypothetical continent of "Lemuria," and also to ascertain whether there are ridges and peaks in this semi-enclosed ocean, such as the Meteor Expedition found in the Atlantic. The study of the zonal distribution of the marine fauna every 50 or 100 fathoms downwards is to be attempted, special attention being paid to the fauna at Murray's Mud Line and to its relationships to currents and food supplies.

Temperature, salinity, oxygen-content and other chemical observations will be made at stations on all the traverses, both on the surface and at various depths. In particular, it is hoped to ascertain thereby the general circulation of the waters in the Arabian Sea, how far there is an inflow from the Antarctic and surrounding seas to balance the heavy evaporation; these will be checked by taking samples of the floating fauna at different depths, in which there may well be the young transparent eels which have been

so brilliantly studied by Dr. Schmidt, of Denmark. Bottom deposits will be obtained by sounding-leads, especially in connection with the problems set down for investigation by Sir John Murray.

### THE OFFICIAL MAP OF THE UNITED STATES

COMMISSIONER CHARLES C. MOORE, of the General Land Office, has announced the publication of the sixty-fifth official map of the United States. This map, for which Congress appropriated \$15,000, contains the latest information concerning elements required to constitute a complete map. It is detailed to the degree of indicating the position of every surveyed township in the United States. It contains the latest information as to the location of national forests, Indian reservations, national parks, military and all other reservations that are controlled by the Federal Government. It shows the latest changes in railroad routes and, indicated by the type in which their names are printed, the population classification of towns.

The map is used by government departments, government offices throughout the nation and the embassies and consulates of the world. Mounted on cloth and attached to a roller, it is sold by the Superintendent of Documents. The map, which is built on a scale of 37 miles to the inch and is seven feet wide, shows not only continental United States but all its possessions. It is appropriate for use in schools and is so colored as to show the historical development of the United States.

The master plates, engraved some 75 years ago, are still in the General Land Office. For many years a new map was made each year, but of late the practice has been to make one each two years. No sooner is one edition made than work is begun on the subsequent edition. Clarence E. Ruebsam, map engraver, works constantly on the plates, erasing old lines and engraving new developments. In the days when skilled engravers were rare in this country, the government sent to Germany for Adolph M. Maedel, who spent his life on the work. He trained a son, August, to be a map engraver, and he devoted a large part of his life to the Federal Government. Mr. Ruebsam, a descendant, is the fourth generation of the Maedel family that is devoting itself to maintaining the reliability of the map.

### REELFOOT LAKE BIOLOGICAL STATION

The executive committee of the Reelfoot Lake Biological Station, under management and control of the Tennessee Academy of Science, announces the following consulting staff for the period 1932-33:

*Archeology*: Dr. P. E. Cox, state archeologist, Nashville; J. D. Taylor, Bristol.

*Bacteriology and Protozoology*: Dr. W. S. Leathers,

Vanderbilt University, Nashville; Dr. E. L. Bishop, state commissioner of health, Nashville; Dr. E. W. Goodpasture, Vanderbilt University, Nashville; Dr. L. M. Graves, superintendent, Department of Health, Memphis; Dr. John L. Jelks, Memphis; Dr. L. E. LePrince, U. S. Public Health Service, Memphis; Dr. I. D. Michelson, University of Tennessee, Memphis; Dr. P. W. Allen, University of Tennessee, Knoxville.

*Botany*: Dr. L. R. Hesler and Dr. H. M. Jennison, University of Tennessee, Knoxville; Dr. A. John Schwarz, University of Tennessee, Memphis; Dr. C. E. Moore, West Tennessee Teachers College, Memphis; Dr. J. B. Lackey, Southwestern University, Memphis; Dr. C. W. Davis, Union University, Jackson; Dr. R. G. Turner, University of Tennessee Junior College, Martin.

*Chemistry*: Dr. H. W. Robinson, Dr. L. J. Bircher and Dr. John T. McGill, Vanderbilt University, Nashville; Dr. C. O. Hill and Dr. J. H. Robertson, University of Tennessee, Knoxville; Dr. W. A. Webb, George Peabody College, Nashville; Dr. G. H. Hayden, West Tennessee Teachers College, Memphis.

*Entomology*: Dr. G. M. Bentley and Dr. S. Marcovitch, University of Tennessee, Knoxville.

*Forestry*: Dr. J. O. Hazard, state forester, Nashville.

*Geology*: Dr. W. F. Pond, state geologist, Nashville; Dr. L. C. Glenn and Dr. W. B. Jewell, Vanderbilt University, Nashville; Dr. C. H. Gordon and Dr. G. M. Hall, University of Tennessee, Knoxville.

*Histology and Embryology*: Dr. C. S. Simkins, Dr. D. S. Pankratz and Dr. T. S. Eliot, University of Tennessee, Memphis.

*Pharmacology*: Dr. P. D. Lamson, Dr. H. A. Wells and Dr. H. S. Wesson, Vanderbilt University, Nashville; Dr. A. Richard Bliss, Jr., University of Tennessee, Memphis.

*Physiology*: Dr. W. E. Garrey, Dr. R. A. Ashman and Dr. C. E. King, Vanderbilt University, Nashville.

*Ornithology*: B. B. Coffey, Memphis; A. F. Ganier, Nashville; Dr. C. R. Mayfield, Vanderbilt University, Nashville.

*Zoology*: Dr. E. E. Reinke, Vanderbilt University, Nashville; Dr. J. M. Shaver, George Peabody College, Nashville; Dr. E. B. Powers and Dr. G. A. Canning, University of Tennessee, Knoxville; Dr. J. B. Lackey, Southwestern University, Memphis.

A. R. BLISS, JR.

*Chairman, Executive Committee*

### SIGMA XI LECTURES AT THE UNIVERSITY OF CALIFORNIA AT LOS ANGELES

FOLLOWING is the complete program of public lectures delivered in the academic year 1931-32 under the auspices of the Sigma Xi Club of the University of California at Los Angeles. The officers of the club for the year were: *President*, Dr. Samuel J. Barnett, chairman of the department of physics, and *Secretary*, Dr. Frederick C. Leonard, chairman of the department of astronomy.

*September 30*: Dr. Seth B. Nicholson, astronomer, Mt. Wilson Observatory of the Carnegie Institution of Washington, "Sunspots and the Weather" (illustrated).

*October 14*: Dr. F. L. Ransome, professor of economic

geology in the California Institute of Technology, "The Geology of the Boulder Dam Site" (illustrated).

*November 4:* Dr. William John Miller, chairman of the department and professor of geology, University of California at Los Angeles, "The Geology of the San Gabriel Mountains" (illustrated).

*November 18:* Dr. Walter Mosauer, instructor in zoology, University of California at Los Angeles, "The Locomotion of Snakes and its Anatomical Basis" (illustrated).

*December 2:* Dr. Shepherd Ivory Franz, chairman of the department and professor of psychology, University of California at Los Angeles, "Amnesia, or Lost Identity."

*January 5:* Dr. Willem de Sitter, professor of astronomy and director of the Observatory, University of Leiden, Holland, "The Origin of the Solar System."

*January 6:* Dr. Bennet M. Allen, professor of zoology, University of California at Los Angeles, "Some Recent Studies upon the Glands of Internal Secretions" (illustrated).

*February 15:* Dr. Albert Einstein, professor of theoretical physics in the University of Berlin, "The Geometric Interpretation of the Gravitational and Electric Field." (Dr. Einstein's address was delivered in German, but was translated by Dr. Richard Chase Tolman, professor of physical chemistry and mathematical physics in the California Institute of Technology.)

*February 23:* Dr. William Frederick Durand, profes-

sor emeritus of mechanical engineering, Stanford University, "Science and Civilization."

*March 2:* Dr. Joseph Kaplan, assistant professor of physics, University of California at Los Angeles, "The Aurora and its Spectrum" (with demonstrations).

*March 18:* Dr. Russell Tracy Crawford, professor of astronomy, University of California, "The Orbits of the Planets and Comets."

*March 30:* Dr. A. O. Leuschner, director of the Students' Observatory, chairman of the Berkeley astronomical department and professor of astronomy, University of California, "The Recently Discovered Delporte Object."

*April 6:* Dr. E. R. Hedrick, chairman of the department and professor of mathematics, University of California at Los Angeles, "Infinites."

*April 20:* Dr. Max S. Dunn, associate professor of chemistry, University of California at Los Angeles, "Amino Acids and their Significance" (illustrated).

*May 4:* Dr. J. A. Anderson, astronomer in the Mt. Wilson Observatory of the Carnegie Institution of Washington and the California Institute of Technology, "The Telescope in Theory and in Practice" (illustrated).

*May 18:* Dr. Charles K. Edmunds, president of Pomona College, Claremont, California, "Some Physical Aspects of China" (illustrated).

*May 25:* Dr. Loye Holmes Miller, chairman of the department and professor of biology, University of California at Los Angeles, "The Desert Tortoise of California" (illustrated).

## SCIENTIFIC NOTES AND NEWS

DISPATCHES from Berlin to the daily press report that Professor Albert Einstein has accepted a life appointment as a member of the staff of the newly established Institute for Advanced Study at Newark, New Jersey, of which Dr. Abraham Flexner is director. It is stated that Professor Einstein will stay in the United States each year for five months only, spending the rest of the time in Germany.

DR. IRVING LANGMUIR, director of the research laboratory of the General Electric Company, Schenectady; Dr. Louis M. Dennis, professor of inorganic chemistry at Cornell University, and M. Constantin Levaditi, of the Pasteur Institute, Paris, have been elected members of the Academy of Sciences at Halle.

DR. WILLIAM BOWIE, in charge of the division of geodesy of the U. S. Coast and Geodetic Survey, has been elected an honorary member of the State Russian Geographical Society.

THE Priestley medal for distinguished service to chemistry, which was awarded last spring to Dr. Charles Lathrop Parsons, secretary of the American Chemical Society, was presented to him at the recent meeting of the society in Denver. The Priestley medal was awarded first in 1923 to Ira G. Remsen, president

of the Johns Hopkins University. The second award was made in 1926 to Edgar Fahs Smith, provost of the University of Pennsylvania, and the third to Francis P. Garvan, president of the Chemical Foundation.

THE order of the Red Star of the Soviet government, bestowed for "outstanding achievements in defense of the country," has been awarded to Colonel Hugh L. Cooper, of Stamford, Connecticut. The award was made for designing and constructing the Dnieprostroy power development in the southern Ukraine. Six members of Colonel Cooper's staff received the Order of Lenine for "outstanding achievements in socialist construction."

DR. THOMAS GILLMAN MOORHEAD, Dublin, president of the Royal College of Physicians of Ireland and regius professor of physic at Trinity College, University of Dublin, was chosen president-elect of the British Medical Association at the recent annual meeting held in London. He will succeed Lord Dawson of Penn.

EARLY in July last the pharmacologists of Great Britain met in London and founded the British Pharmacological Society. Professor J. A. Gunn, of the University of Oxford, was elected first president of

the society. At the first regular meeting Dr. John J. Abel, professor emeritus of pharmacology in the Johns Hopkins University and president of the American Association for the Advancement of Science, and Dr. Hans Horst Meyer, professor emeritus of pharmacology in the University of Vienna, were elected honorary foreign members.

DR. HERBERT S. BIRKETT, emeritus professor of otolaryngology, McGill University, was the guest of honor at a dinner given to him by his colleagues at the end of the school year.

THE University of Paris recently conferred an honorary doctorate on Dr. C. V. Raman, professor of physics at the University of Calcutta.

THE French National Surgical Society has awarded its gold medal to Professor Leriche of Strasbourg. The medal, which is accompanied by a prize of 5,000 francs, was instituted by Professor Lannelongue, and has been successively awarded to Sir Victor Horsley, Dr. Henri Gaudier and Dr. George W. Crile.

THE Dr. Martini Foundation Prize of Hamburg, of the value of 1,200 marks, has been divided equally between Dr. Otto Fischer, of Tübingen, for his studies on the pathology and epidemiology of East Africa, and Dr. Helmut Schmidt, of Hamburg, for his work on narcosis and anesthesia.

THE Karl Ludwig Medal, which is awarded annually in Germany for the best original work on diseases of the circulation, has been awarded to Professor Friedrich Moritz, of Cologne.

THE Royal Asiatic Society has awarded its gold medal "in recognition of distinguished services in Oriental research" to Sir Aurel Stein.

DEAN R. A. SEATON, of the Kansas State Division of Engineering, was elected president of the Society for the Promotion of Engineering Education at the recent annual meeting at Corvallis, Oregon. Dean Seaton succeeds Dean H. S. Evans, of the University of Colorado. Other new officers of the association include Dean H. S. Rogers, of the Oregon State College, and Paul Clarke, of the University of Maine, vice-presidents, and F. L. Bishop, University of Pittsburgh, secretary. W. O. Wiley, New York, was reelected treasurer.

E. O. ULRICH, M. R. Campbell and F. C. Schrader, geologists of the U. S. Geological Survey, have been retired under the provisions of the economy act.

DR. ERNST GELLHORN, formerly professor of physiology at the University of Oregon and at the University of Halle, has recently been appointed to a professorship in the department of physiology, in the College of Medicine of the University of Illinois.

DR. CARL E. BADGLEY, head of the department of orthopedic surgery at the Henry Ford Hospital at Detroit, has been appointed professor of surgery in charge of orthopedics in the School of Medicine of the University of Michigan. Dr. Badgley was formerly associate professor of surgery at the university.

PROFESSOR HARRY NEVILLE JENKS, consulting sanitary and hydraulic engineer of Berkeley, California, formerly of the Iowa State College, will join the faculty of the School of Engineering at the University of North Carolina. He succeeds Dr. Thorndike Saville, who resigned recently to accept a professorship at New York University.

DR. C. L. LEFEBVRE has been appointed assistant professor of botany of the Kansas State College, to fill the vacancy left by the death of Miss Nora Dalbey.

PROFESSOR F. WOOD JONES, professor of anatomy in the University of Melbourne, will go to Peking as head of the department of anatomy at the Peking Union Medical College, during the absence of Professor Davidson Black on leave in Europe and America during the next six months.

ACCORDING to dispatches to the daily papers, Dr. Roy Chapman Andrews has closed the headquarters at Peiping of the Central Asiatic Expedition for the American Museum of Natural History on account of lack of cooperation of the government. The Manchukuo government has offered him every facility to complete the work of the expedition and his headquarters will be transferred to Mukden.

THE British Medical Research Council has made the following awards of Dorothy Temple Cross Fellowships for 1932-33, under the terms of the benefaction for research fellowships in tuberculosis: Veronica B. F. Dawkins, resident medical officer, Maltings Farm Sanatorium, Colchester; G. M. Dean, formerly of the department of surgery, University of Aberdeen; Evelyn M. Holmes, formerly assistant tuberculosis officer, Welsh National Memorial Association; J. N. O'Reilly, formerly house physician, Brompton Hospital, London; Dr. W. G. Scott-Brown, assistant surgeon, Throat, Nose and Ear Department, Royal Free Hospital, London. Dr. Dean will study problems of tuberculosis at Baltimore, the others at different European centers.

DR. MAX PLANCK, of Berlin, has been invited by the Physical Society, London, to deliver the Guthrie lecture.

AT a recent meeting of the Osler Club, Dr. R. W. Chapman, of the Clarendon Press, Oxford, delivered the fifth Oslerian Oration, on "Book Production in the Eighteenth Century."

SIR ARTHUR STANLEY EDDINGTON, Plumian professor of astronomy at the University of Cambridge, will give the only public lecture at the meeting of the Astrophysical Union which will be held at Cambridge from September 2 to 9. His subject will be "The Expanding Universe." The lecture will be held at the Massachusetts Institute of Technology on Wednesday, September 7. Sir Arthur will deliver three radio addresses on "Our Changing Universe" while he is in this country. The addresses will be under the auspices of the National Advisory Council on Radio in Education, and will be broadcast over the WEAF red network of the National Broadcasting Company, on September 8, 15 and 22, from 9:00 to 9:30 P. M. In the first of these addresses Sir Arthur, it is expected, will discuss the eclipse.

THE twenty-sixth annual convention of the Illuminating Engineering Society will be held at Swampscott, Massachusetts, on September 27, 28 and 29.

THE fourth Italian Congress of Anatomy will be held at Pavia from October 14 to 17, when the centenary of the death of Antonio Scarpa will be celebrated.

THE second International Congress on Otorhinolaryngology will be held in Madrid, September 27 to 30.

THE College of Medicine, University of the Philippines, recently observed the twenty-fifth anniversary of its founding with a banquet and special program at the School of Hygiene and Public Health, Manila.

A SCHOOL of Agriculture, to be directed by Dr. Chaim Weizmann, is to be established in Palestine by the Hebrew University. It will cooperate with the Jewish Agency's Agricultural Experiment Station.

THE Model Shop of The Museum of Science and Industry, founded by Julius Rosenwald, in Chicago, has installed a scale model of a complete salt plant. It is a gift to the museum from Mr. Joy Morton, of Chicago, and is being loaned to the Morton Salt Company for use in its space at the Century of Progress Exposition. It will then be placed permanently on exhibition at the museum building in Jackson Park. The Plant Model is eighteen feet long and tells the story of salt production and manufacture from the brine well to the packaged product. The visitor presses a button and sets in operation pumps which force water and compressed air down into the double casing of the salt well. This method eliminates drilling, shoveling, mine cars and trains, hoists, crushers and all the other tool equipment used in mining other minerals.

A NEW building for the department of mining and metallurgy at the University of Wisconsin will

be open this month. The building is of fireproof construction throughout, and contains about 28,000 square feet of laboratory floor space. The first floor contains a crushing and screening room, ore dressing room, the ceramics department, and a room housing the physical testing apparatus. A lecture room and wash-room are also included in this central section of the building. A large physical metallurgy laboratory containing various furnaces and accessory apparatus is placed at the west end of the first floor, while on the east end a similar laboratory houses the larger furnaces for class demonstrations in industry processes. On the second floor of the building are the various physical and chemical laboratories, the lecture room and faculty offices. The central section contains a temperature standards laboratory, a pyrometer laboratory, and a suite of three rooms for microscopic examination of metals. A photographic dark room, three offices and a lecture room complete this section. A large lecture auditorium, a museum, a number of graduate seminar rooms and an office room are located on the west end of this floor, while on the east end there is a large lecture room and a chemical laboratory for class demonstration in industrial practice.

THE new laboratory building for teaching and research was recently completed at George Washington University Medical School. According to the *Journal* of the American Medical Association this building makes possible the reorganization of the fundamental scientific departments. With the remodeling of the old medical building, which will include segregating the departments of anatomy, pathology, physiology and pharmacology on separate floors during the summer, the school of medicine will possess facilities for advancing its program in medical education and investigative work. The new \$75,000 structure will also house a central laboratory to serve the University Hospital and the clinical departments. Adjoining this is a fully equipped laboratory for the teaching of clinical microscopy, all under the supervision of a full-time director who will develop this work in the department of medicine. The new building also provides a teaching laboratory for the department of bacteriology, hygiene and preventive medicine and offices and individual laboratories for the members of the department. The fourth floor communicates with the old medical school building, where will be located the department of pathology. The third floor of the new building will communicate with the department of biochemistry, while the second floor is connected with the medical library, now under the supervision of a trained librarian. Construction on a new addition to the University Hospital building began in May.

*The Wistar Institute News* writes: "General Isaac

J. Wistar, who endowed The Wistar Institute in 1893, was noted for his ability to predict the future. On July 14, 1902, in a long testamentary letter addressed to the Board of Managers and filed for the information of those who were to follow him, he stated that The Wistar Institute should 'build its new buildings during one of these periodical times of depression when the cost of building construction drops 50 per cent. or more.' On July 14, 1932, just thirty years later, the officers of the institute signed contracts for the new building anticipated by General Wistar and which will be built during the next few months. The work of demolishing the old police station property begins to-day, July 15. Plans for the new construction work have been in the course of preparation for some months past. The new addition and its equipment, especially the equipment for the Wistar Institute Press, will give the institute a very complete and modern outfit for the publication of biological research journals. The new building will also house Dr. Helen Dean King's special colony of inbred albino rats and the cage-bred Norway rats from which numerous mutations have emerged."

THE name of the California National Forest, in the State of California, has been changed, by executive order of the President, to Mendocino National Forest, to avoid the confusion growing out of the State and a national forest therein having the same name. Mendocino is the oldest non-Indian name in the entire California coast region; Cabrillo, Spanish explorer, named a prominent cape Mendocino, in 1543, in honor of his patron, Antonio de Mendoza, Governor of New Spain, now Mexico.

At the annual meeting on July 8 of the trustees of the Beit Fellowships for Scientific Research, tenable at the Imperial College, South Kensington, which were founded and endowed in 1913 by the late Sir Otto Beit, new fellowships of the value of £240 a year, beginning September, 1932, were awarded to Mr. Robert Milner Shackleton, B.Sc. (Liverpool), formerly of Sidcot School, Somerset, 1921-26; of the University of Liverpool, 1927-31; and Imperial College, 1931 to date, for research on the geology of the area about Moel Hebog. Mr. Eric Gwynne Jones, B.Sc. (Lond.), formerly of the People's College, Nottingham, 1918-22; High Pavement School, Nottingham, 1922-27; University College, Nottingham, 1927-31, and the Einstein Institute, Astrophysics Observatory, Potsdam, 1931-32, for research on hyperfine structure of spectral lines. Mr. Reuben Louis Rosenberg, B.A., M.A. (University of Capetown), formerly of the University of Capetown, 1926-29, and the University of Berlin, 1930 to date, for theoretical investigations in topics connected with quantum-mechanics. Mr. Oliver Brentwood Westcott, B.Sc. (Lond.), Ph.D., formerly of Hele's School, Exeter, 1921-27, and University College, Exeter, 1927 to date, for research on the electro-deposition of tin with a view to the establishment of the precise conditions under which crystalline deposits may be obtained and to avoid the unsatisfactory spongy deposits which result from present processes. In addition, the fellowships awarded a year ago to Mr. W. H. Wheeler, B.A., D.I.C., for research in chemical technology, and Mr. J. I. Armstrong, M.Sc., for the plant physiology research were extended for a second year.

## DISCUSSION

### PALEOZOIC GLACIATION IN ALASKA

IN a recent paper on "Glaciation in Alaska"<sup>1</sup> Dr. S. R. Capps gives an interesting general review of the wide-spread glaciation of late Pleistocene age, and also notes evidences of pre-Wisconsin glaciation. To this he adds some comments on the ancient rocks, reported to be of glacial origin, which have been observed by geologists in various parts of Alaska. In discussing the Paleozoic glacial beds he lists eight localities from which they have been described and alludes to the ideas of Cairnes, Kirk and Blackwelder. One case reported by Kirk from Prince of Wales Island on the south coast of Alaska he characterizes as being "fairly well established." All the others he classifies as either "questionable or doubtful."

As I have examined several of these ancient and

<sup>1</sup> Stephen R. Capps, "Glaciation in Alaska," U. S. Geol. Survey Prof. Paper 170-A, pp. 1-8. 1931.

supposedly glacial formations of Alaska, I may be permitted to say that I think the probability that some of them are really of glacial origin is much stronger than Capps appears to believe. I am constrained to comment on the subject also because the author has made references to "unpublished notes by Blackwelder." These so-called notes are in fact a complete manuscript report of 180 pages containing a full account of my reconnaissance survey of 1915 from Eagle to Circle on the Yukon, thence west to the White Mountains and finally down Beaver and Birch Creeks to Beaver Station in the Yukon Flats. The report is accompanied by detailed maps, diagrams, stratigraphic tables, photographs, lists of fossils and as full interpretations of the data as seemed justifiable. This manuscript was intended for publication and, although it has never reached that stage, the maps, photographs, information and opinions which it contained are gradually making their

way into print through the medium of papers written by other members of the Geological Survey who have had access to it. As such excerpts have usually been neither literal nor complete quotations they have not always represented my own views accurately, and so it seems advisable now to clear up some misapprehensions, at least so far as the old tillites are concerned.

Although Capps does not discuss the criteria by which ancient glacial deposits may be identified, he implies his opinion regarding some of them, and it may be assumed that an accomplished geologist who has spent many years in Alaska is well qualified to make such identifications.

Glacial deposits in general are of two kinds—that which is made directly by glaciers and those made in associated waters. The former is well known as till, and the latter comprise stream gravel and sand, delta deposits, varved lake clays, marine boulder clays and others. Each of these types of deposit is distinctive, but till is perhaps the most peculiar of them all.

Till, which upon induration becomes tillite, may be confused with only a few other deposits<sup>2</sup> if it is clearly exposed and has not suffered strong metamorphism. It is characterized by lack of stratification and assortment of its constituent particles, by the presence of scattered boulders, some of which may be soled or faceted and covered with scratches or polish. The only non-glacial deposits likely to be confused with it are landslides, mudflows and certain residual soils. The last of these exhibit advanced chemical decay in both boulders and matrix and generally but little variety of lithologic contents. Landslide and mudflow deposits are more difficult to distinguish from till, but they are rarely extensive individually, seldom show striated pebbles, practically never contain soled pebbles (unless inherited) and their associated stratified deposits are usually unlike those of the glacial series.

When the field geologist finds a coarse bouldery rock well exposed in a cliff he may at first entertain several hypotheses regarding its origin. It may be suspected of being a pyroclastic mudflow, but this explanation is soon eliminated if he finds many boulders of quartzite, granite and limestone, but none of lava.

He may suppose it to be an ordinary mudflow from a mountain canyon, but mudflows are rarely more than 10 to 15 feet thick and they are usually interbedded in series with torrential gravel and sand deposits as components of an alluvial fan.

He may suspect it of being a landslide. Even this still more probable hypothesis he will be inclined to discard if he finds a number of peculiar faceted stones

<sup>2</sup> Deposits of uncertain origin but resembling till may be called "tilloid."

some of which are well polished or covered with parallel scratches. He must of course be able to distinguish from glacial markings the slickensides caused by faulting.

His final conclusion that it is of glacial origin is still further strengthened by finding wisps or lenses of stream-gravel embedded here and there in the till, or by its association with varved clay and silt beds in which pebbles and boulders are scattered. Such assemblages as these have strengthened the identification of the tillites at Squantum in Massachusetts, in southern Ontario, the Transvaal, the Indian Plateau, South Australia and many other parts of the world. Only the somewhat rare good fortune of finding a grooved "pavement" beneath the tillite could add a final touch of confirmation to testimony already grown sufficient.

Applying these criteria to the Alaskan cases cited by Capps, we may examine several of the latter and judge whether his skepticism is warranted.

In a series of cliffs along Beaver Creek, just above the mouth of Victoria Creek, there are hundreds of feet of splendid exposures of a massive gray bouldery slate. This locality is between the White Mountains and the Yukon Flats. The boulders are without order, and the slate shows no hint of stratification. It contains many scattered blocks and pebbles of gray and black slates, with white and gray quartzites, gray-wacke, black chert, quartz, dolomite and granite, ranging in size up to a diameter of 40 inches. The whole mass has been so heavily compressed that the softer stones have been mashed into lenses, but the quartzites, comprising nearly all the large boulders, are unaffected. Many of them are sub-angular and some resemble glacial forms, but the advance of metamorphism in the slate has caused the matrix to adhere so tightly to all the boulders that none of the original surfaces were visible, and hence none could be examined for striations. Although the boulder bed appears to be at least 100 feet thick, it has been so intensely folded that it was impracticable to work out the structure in the short time available in 1915. In one of the cliffs the boulder bed is closely associated with evenly laminated light and dark gray slate suggestive of seasonal deposition in a lake.

In regard to these strata on Beaver Creek, Capps<sup>3</sup> quotes Mertie, apparently with approval, as doubting "the validity of Blackwelder's conclusion as to their glacial origin." The word "conclusion" in this sentence is misleading and unwarranted, for my report states merely that the slate "is suspected of being glacial in origin." In view of the fact that the Beaver Creek locality shows a bed of wholly structureless boulder clay (now metamorphosed into slate), associ-

<sup>3</sup> *Op. cit.*, p. 8.

ated with laminated slates and containing widely scattered erratic blocks of considerable variety, there is surely ample reason for suspecting glacial origin. I think the conditions on Beaver Creek not only justify much more than a mere suspicion of glacial origin, but entitle that hypothesis to strong preference, although not as yet to full acceptance.

In the canyon of the Yukon River, between Eagle and Circle, there are two outcrops of tilloid conglomerates, only one of which is mentioned by Capps. The one omitted is on the south bank six and one half miles west of the mouth of Nation River. There a massive bed of boulder clay 80 feet thick was deposited in the midst of a series of black shales and dolomites, presumably of marine origin. The gray clay is now a hard argillite sprinkled with pebbles and subangular boulders of various rocks. During the very cursory examination that we made no striae were found. The material closely resembles till in general appearance, but I do not urge the acceptance of that theory of origin. The place should be examined more thoroughly by others.

The locality cited by Capps is on the west bank of the Yukon River, eight miles north of Woodchopper Creek, and south of Circle. There a long cliff gives an almost perfect exposure of a layer of bouldery slate more than 100 feet thick. The rock is a dull gray argillite in which slaty cleavage is only moderately developed. The microscope shows the matrix to consist of a heterogeneous mixture of minerals derived from clay with angular fragments of such rocks and minerals as quartz, dolomite, chert and feldspar. Through this matrix, which is indistinguishable from that of many well-known tillites, there are sprinkled at random subangular pebbles and boulders of dolomite, chert, quartzite and several kinds of slate, ranging up to at least 30 inches in diameter. These erratics are wholly without arrangement, and the matrix shows no sign of stratification. Recrystallization of the matrix has caused it to adhere so tightly to the surfaces of the pebbles that in the course of an hour's careful search among hundreds of them only four were found that revealed even patches of the original abraded surface. However, each of these four pebbles of fine-grained dolomite show typical glacial polish and fine parallel striae, that have fully satisfied all the glacialists to whom I have shown them. Many of the erratics the surface of which could not be examined nevertheless were soled or faceted, and some even revealed the so-called flatiron shape which is peculiar to glacial abrasion.

Whether Capps or Mertie have ever examined this cliff with adequate care is not stated in their reports and they give no reason for the expressed opinion that they doubt the glacial origin of the deposit. To

me it seems that the facts in the case leave very little ground for uncertainty. The glacial origin of the deposit appears to be no more questionable than that of the generally accepted tillites at Nan-tou in China, at Squantum in Massachusetts, in the Salt Range of India, or in the Cobalt district of Ontario. The evidence is essentially alike in all these cases.

On general grounds there would seem to be no reason for not expecting to find glacial deposits of many ages in Alaska. Had the geologist described desert or tropical deposits, a skeptical attitude would be more justified than in reference to glacial beds in a subarctic region. Finally, the author's caution regarding the Paleozoic tillites in Alaska is rather out of harmony with his confident attitude toward a certain early Pleistocene deposit which he himself found in the Alaska range. This he describes<sup>4</sup> as "a deposit of deeply oxidized and weathered material that in composition, lack of assortment and shape of included boulders and blocks seems certainly to represent a glacial moraine. The included boulders and rock fragments, however, are all so weathered and decomposed that their original surfaces have been lost. No striae were found, but few of the rocks were firm enough to retain striae. I believe this deposit to be a remnant of an ancient glacial moraine." It is reasonable to ask whether the evidence in this case is even as good as in the Paleozoic deposits which he regards as doubtful, especially the one in the locality below Woodchopper Creek.

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### IS AMMONIUM HYDROXIDE TOXIC TO COTTON PLANTS?

IN an article in the June 17 number of *SCIENCE*, Mr. Tiedjens has taken exception to conclusions given by us in an article on "Free Ammonia Injury with Concentrated Fertilizers."<sup>1</sup> The many misinterpretations of our claims and the weakness of some of the evidence he presents in contradiction of our conclusions force us to point out some of the major discrepancies.

In a previous article,<sup>2</sup> Tiedjens and Robbins contended that we could not have had any considerable concentration of free ammonia formed by the ammonification of cottonseed meal, as other investigators found that ammonification was a gradual process while nitrification was rapid. Our published data showed the reverse was actually the fact.

Tiedjens has said that our interpretation "would

<sup>4</sup> *Op. cit.*, p. 7.

<sup>1</sup> L. G. Willis and W. H. Rankin, *Ind. and Eng. Chem.*, 22: 1405-12, 1930.

<sup>2</sup> V. A. Tiedjens and W. R. Robbins, *N. J. Agr. Exp. Sta. Bul.*, 526, 1931.

imply that the cotton plant is peculiarly sensitive to extremely low concentrations of ammonia nitrogen." We had stated that "the injury is related to a high concentration of free ammonia in contact with the roots."

He grew cotton "in sand cultures with sulphate of ammonia, ammonium hydroxide and calcium nitrate, respectively. Ammonium hydroxide was supplied in a complete nutrient solution at pH 8." "The concentration of nitrogen as ammonia in these cultures was higher than that of the total nitrogen in the cottonseed meal which was employed by Willis and Rankin."

The cottonseed meal we used contained 6.02 per cent. of nitrogen. Ordinary concentrated ammonium hydroxide, with 26 per cent.  $\text{NH}_3$  has about 20 per cent. of nitrogen. Tiedjens' cultures, in which cotton grew satisfactorily, must therefore have been made up to contain 30 per cent. of concentrated ammonium hydroxide. We question the accuracy of this statement.

No details were given of the method of limiting the cultures containing ammonium hydroxide to pH 8.0. We are of the opinion that in establishing this low value arbitrarily he has at the same time and by the same means reduced the ammonium hydroxide to a correspondingly low concentration. If we are correct, the results given by Tiedjens are valueless in support of his contention that ammonium hydroxide is not more toxic than other nutrients.

It appears that our rate of fertilization was not correctly understood, even though we stated that this "was calculated on the basis of all fertilizer being placed in furrows 6 inches wide, spaced 4 feet apart and with the fertilizer mixed with one inch of soil in the bottom of the furrow." The soil in the pots was considered to represent a section of the drill.

Tiedjens states that we used "only 16 pounds of nitrogen per acre." This is about the average initial rate of application for cotton in the field, but it should be evident that the local concentration in the drill is equivalent to eight times the apparent rate.

It was said of our results that they "were apparently obtained where the soil buffer systems was inadequate." Inasmuch as nearly half of the fertilizers used in this country are applied to soils having this limitation, we see in respect of the soil used no basis for criticism of any generalizations we have made.

We do not claim infallibility for our deductions, but we find nothing in Mr. Tiedjens' work that can logically be construed to be contradictory to any of them. We must therefore hold to the opinion that free ammonia was the cause of the injury we observed, until it is shown by competent evidence that the same effect could have been produced under the

conditions of our experiment by a factor we overlooked. And until we have this evidence we must consider that the use of ammonium hydroxide as a fertilizer constitutes a hazard to plants, except under very strictly prescribed conditions.

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#### A POSSIBLE HORMONE-SECRETING REGION IN THE GRASS COLEOPTILE

CAREFUL experiments on phototropism in the coleoptiles of *Avena sativa* and other grasses, notably by Went and his associates, have apparently demonstrated the presence in this organ of a growth-producing hormone or "Wuchsstoff." An important aspect of the problem is a determination of the region where this substance is produced and the means of its transportation to the zone of bending. The only histological work to date is that of Tetley and Priestley,<sup>1</sup> who report that in coleoptiles of *Zea Mays* there seems to be no possible region for the production of such a substance, since all the tip cells of the coleoptile are highly vacuolate or seem otherwise to be inactive. These authors also believe that there is no possible path of transportation in the fibro-vascular bundles, as there is a strong upward movement of water and sap generally in the xylem, and the phloem elements are not yet fully differentiated. They conclude that phototropism here is not the result of any chemical substance but rather of differential tissue permeability on the two sides of an unequally light-stimulated coleoptile. They find no morphological regeneration in decapitated coleoptiles.

The hypotheses of the existence of a growth hormone evidently depends, at least in part, upon the demonstration of an appropriate histological structure for its production. In an endeavor to secure evidence on this point, experiments and histological studies have been carried on by the author with twenty genera of grasses as well as with certain dicotyledonous plants. The seeds were soaked in sterile distilled water and germinated in a moist chamber on moist filter paper in sterile Petri dishes. Some coleoptiles were studied directly, others after exposure to unilateral light. The length of coleoptile, time of exposure and other conditions varied with the experiments. Some ten thousand coleoptiles were used, mostly of *Avena sativa*, since this species is particularly favorable and has been the most commonly studied.

<sup>1</sup> U. Tetley and J. H. Priestley, "The Histology of the Coleoptile in relation to its Phototropic Response," *New Phytol.*, 26: 171-186. 1927.

The coleoptiles were fixed with best results in Allen's B 15 fluid, although various modifications of Flemming's and Merkel's fluids were fairly successful. Chromo-acetic acid, formalin acetic alcohol and Bouin's and Carnoy's fluids gave rather negative results. Sections were stained chiefly with Flemming's triple stain, although Heidenhain's iron-alum-haematoxylin was satisfactory, especially with a safranin counter-stain. Living material was also studied.

In general the epidermal layer is highly developed, suggesting for it a secretory function. Over the tip of the coleoptile the cells are particularly numerous, with large, deeply-staining nuclei, dense cytoplasm, small vacuoles and many granules. These cells are essentially isodiametric. Continuous with them and extending down the sides of the coleoptile, the epidermal cells gradually become longer, finally reaching a length of from twenty to forty times their width. These cells also have large nuclei and abundant contents. There is a marked contrast, both at the tip and along the sides, between these epidermal cells and the tissue immediately beneath, the cells of which have smaller nuclei and are highly vacuolate.

It is suggested that the hormone is produced in the tip cells, which would explain the well-known results of decapitation. It is further suggested that this hormone is transported to the region of bending by rapid streaming of cytoplasm in the long epidermal cells. Cyclosis has been observed in the epidermis of intact coleoptiles of all genera of grasses studied, and coleoptiles removed from young plants have shown active streaming in Russian mineral oil for a period of 840 hours under ordinary conditions. The

rate corresponds roughly with the time necessary for transportation between illumination and response.

A comparison of the illuminated and unilluminated sides of the coleoptile in stained sections shows no morphological differences, and in decapitated stumps there is no immediate visible regeneration, suggesting that the presence of a hormone involves no evident difference other than change in cell size.

It may therefore be concluded that an adequate histological basis exists for the secretion and transportation of a growth hormone in the grass coleoptile.

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#### HASSTILESIA TRICOLOR STILES AND HASSALL, 1894—A NEW REPORT

ON February 3, 1932, the junior author brought into the laboratory viscera from two wild rabbits (*Sylvilagus*) killed the day before in the swamps west of Tuscaloosa, Alabama, which he had secured from some hunters. On examination of the intestinal contents of one of the rabbits, a male, the senior author found numerous trematodes. These were fixed and stained with ordinary laboratory technique and determined as *Hasstilesia tricolor* (Stiles and Hassall, 1894). As this is the first report of this species from Alabama, it was thought worth recording. The previous records, according to the Zoological Division, Bureau of Animal Industry, Washington, D. C., are from Maryland, District of Columbia, Virginia, New York, Louisiana and Texas.

WILLIAM NOBLE  
SEPTIMA SMITH

UNIVERSITY OF ALABAMA

## SCIENTIFIC BOOKS

*Seven-place Trigonometric Tables.* By H. BRANDENBURG. xxviii + 340 pp., 2nd Edition, 1931, Alfred Lorentz, Leipzig. Price, bound, 36 marks.

*Six-place Trigonometric Tables.* By H. BRANDENBURG. xxii + 304 pp., 1932, Alfred Lorentz, Leipzig. Price, bound, 32 marks.

COMPUTING machines, including those that enable multiplication and division to be performed with little labor, have an ancestry that goes back several centuries, but it is only in this generation that they have been manufactured in such quantities and of such sturdiness as to make them good bargains wherever any considerable amount of computing has to be done. This news has by no means reached all the people who might profit by it, and even now multiplying machines are not in use among business men,

for example, nearly as much as they deserve to be. For scientific applications (astronomy, geodesy, physics, geometrical optics and the like) the use of such machines has brought with it the necessity for natural trigonometric functions. Hitherto only the logarithms of these functions were required and were available, the computer if need be modifying his formulae, by the introduction of auxiliary quantities or similar devices, so as to transform all the operations to multiplication and division and thus to adapt them for logarithmic use. Some computers seem to be inclined to assume that these logarithmic tables are soon to be entirely superseded by the natural functions. This is surely a mistake, as in many cases the logarithmic computation is still the better. Be this as it may, there has been and is a pressing need for tables of the natural functions. Many authors have

compiled such tables in great variety, differing from each other in the number of decimal places, the intervals between successive arguments, and in their reliability. The two sets of tables before us are in the reviewer's opinion the most useful that have appeared, and ought to be on the shelves of every computer who has to deal with trigonometric formulae. They give all four functions (sine, tangent, cotangent and cosine) for every 10". Differences and proportionate parts are always given. The arrangement is excellent and the typography is good. Both are practically free from error. They differ from each other only in that one gives six decimals and the other seven. In addition the six-place volume contains the cotangent for every second up to 3° to at least seven significant figures; and also the sine and tangent to seven decimals for every 10" in the first degree. Similarly, the seven-place tables contain the cotangent to seven decimals (that is, up to thirteen significant figures) for every second up to 6°, and the sine and tangent to seven significant figures for every 10" in the first degree. Considering the character of these books and the present cost of printing tabular matter, their cost is very moderate.

FRANK SCHLESINGER

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*The Structure and Composition of Foods.* BY ANDREW L. WINTON and KATE BARBER WINTON. Pp. 1-710, figs. 1-274. New York: John Wiley and Sons, Inc. 1932. \$8.50.

THE Wintons, both of whom have worked for many years on food structure and food chemistry both in this country and abroad, have just issued the first volume of a series of books dealing with the morphology and chemistry of foods. This first volume deals with cereals, starch, oil seeds, nuts, oils and forage plants. It is, of course, primarily a compilation of information from all sources on the food plants of the world and is the first work of the kind in English. In addition to its thoroughly dependable assembly of references and information from others, it is unique in its very fine illustrations, consisting principally of drawings made to scale by the authors, which will be invaluable as aids in identifying different plant products by their structure. These, with a ruler which will aid in interpreting the scale drawing, all made to the magnification X 160, will be a first-class aid to pharmacognosists and food microscopists as well as to students and investigators in more scientific fields. Their work on starch deals not only with the well-known types such as potato, corn, arrowroot and sago, but gives additional information on the starch of the banana, the yam, the lotus and a great number of plants of less common use. Even the yam

bean commonly grown in China in the tropics, *Pachyrhizus erosus*, is given satisfactory and definite treatment. The text is, of course, primarily intended as a reference, but contains such a wealth of information about uses and treatment of the different products that it will be found interesting as well as a school guide, although one would scarcely expect it to be adopted as a school text for any except specialists who expect to spend their lives in this field.

To ultra-moderns, who seek the very latest fashions in science as well as in dress, in one respect the book will prove a disappointment. While it deals in the most comprehensive fashion in the chemistry and detailed analysis of the products treated wherever information is available and gives the results of an immense amount of ordinary research, one looks in vain for any mention of those mysterious regulators of human and animal nutrition, the vitamins. To those familiar with the most recent developments in vitamin research, this will perhaps be more of an advantage than a drawback, for vitamin work is, of course, primarily a study of physiological reactions and not of chemical compositions. Any report made this year on vitamin content of food will need to be revised frequently in the near future to make it of any value. Until we know more of the chemistry of these substances, they will still remain for many years in the realm of the mysterious rather than that of science. Unlike most of our American reference books, this book is of truly world-wide scope. Even among the grains one finds side by side information on the Mexican teosinte and the Oriental Coix or Job's-tears, the latter being a valuable food and drug plant of the Orient, but known in this country only as an ornamental. In dealing with the oil seeds, the authors have given ample information on the principal oil plants, such as cocoanut, peanut, soy-bean, linseed and palm nut and of the common edible nuts more frequently used as desserts. Besides these, they tell us much of the composition of weed seeds. Seeds of the common buttercup are poisonous and objectionable as a mixture in grains, which may seem at first a little surprising, although the objectionable features of larkspur and its poisonous character are widely recognized. One is impressed with the number and diversity of the oil seeds of the mustard family, both of economic importance and among the weeds. Cottonseed naturally gets a large share of attention, because of its importance among oil plants.

The text of the section on forage plants is relatively brief, comprising only thirty-eight pages, but is probably ample when one considers that the economic phases of this important group of food crops are dealt with in detail by agricultural experiment stations and other agricultural research institutions.

The tabulated information on composition of hay and of legumes, the structural details and particularly the drawings will prove useful additions to the existing literature on this topic. This book will prove a permanent and important addition to the literature of the world on food and food crops. It might also be said to mark the beginning of American activity

in furnishing reference books of truly world scope, a function that we have been accustomed to regard as a particular prerogative of the Germans before the war. Let us venture to hope that America with her financial resources and world interest will now take her place in surveying world information.

F. T. McLEAN

## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### THE "MOLECULAR STILL" AS A TOOL OF BIOCHEMICAL RESEARCH<sup>1</sup>

THE comparatively unstable nature of many compounds often encountered in biochemical work and the frequent occurrence together in preparations of biological origin of substances of widely varying molecular complexity and weight suggest that the so-called "molecular still" should prove useful in biochemical research as a device for the distillation and purification of such compounds and for the partial or complete separation of such mixtures.

The term "molecular still" is applied to any distillation or sublimation device in which the condensing surface is separated from the evaporating surface by a distance less than the mean free path of the molecules of gas at the pressure used. Ordinarily a very high vacuum is used such as is achieved by the use of a diffusion pump in conjunction with a cold trap. Distillation by this method differs from the usual variety in that most of the escaping molecules proceed to the condenser in an unobstructed path by their own kinetic energy, instead of diffusing or being swept along in a current of gas. A suitable temperature differential is maintained between the evaporating and condensing surfaces. For the complete theory of operation and details of the various types of construction, the original papers should be consulted.<sup>2</sup>

The "molecular still" was first used by Brönsted and Hevesy<sup>3</sup> for the partial separation of the isotopes of mercury and later was suggested for the separation of the higher paraffins by Washburn,<sup>4</sup> who also succeeded in distilling sucrose. It since has been used by other investigators for the separation of mixtures and for other purposes.<sup>5</sup>

<sup>1</sup> Communication No. 99 from the Experimental Station of E. I. du Pont de Nemours and Company.

<sup>2</sup> Brönsted and Hevesy, *Phil. Mag.*, 43: 31, 1922; Washburn, *Bur. Standards Jour. Research*, 2: 476, 1929; Burch, *Proc. Roy. Soc. (London)*, 123: 271, 1929; Hickman, *Jour. Franklin Inst.*, 213: 119, 1932.

<sup>3</sup> Brönsted and Hevesy, *loc. cit.*

<sup>4</sup> Washburn, *loc. cit.*

<sup>5</sup> Burch, *loc. cit.*; Carothers, Hill, Kirby and Jacobson, *J. Am. Chem. Soc.*, 52: 5279, 1930; Carothers and Hill, *Jour. Am. Chem. Soc.*, 54: 1557, 1559, 1566, 1569, 1932; see also Hickman, *Chem. Ind.* 48: 365, 1929; E. K., *Synthetic Organic Chemicals*, 2: 3, 1929.

The complete absence of oxygen and the possibility of the use of low or moderate temperatures should make the molecular still particularly useful in biochemical research where substances sensitive to oxygen and high temperatures are not infrequently encountered. In this laboratory glucose, sorbitol and glycine have been distilled unchanged without difficulty at good rates at temperatures fifty or more degrees below their melting points. Vegetable oils and animal fats have been distilled.<sup>6</sup> Very recently Freudenberg<sup>7</sup> and others have succeeded in preparing methylated cellotetroses in pure form by this means. It should be very easy to separate relatively simple substances from such complex and completely non-volatile materials as proteins and the higher carbohydrates or from inorganic impurities. Where there is a propitious difference in volatility and/or molecular size between the components of a mixture, fractionation can be accomplished. Other applications of this comparatively new tool of research should readily suggest themselves in specific investigations.

On theoretical grounds it is probable that any substance can be distilled unchanged (rates are, however, often extremely slow) if the heat of dissociation of the least stable bond in it is greater than the molecular cohesion. The molecular cohesion of a compound is its molecular heat of evaporation at absolute zero, estimated by extrapolation from data obtained at higher temperatures. This property, which has been studied by Dunkel,<sup>8</sup> appears to be roughly additive, and the approximate value for any compound of known structure can be calculated from a table of values for the various constituent groups. In this connection it is interesting that it has been found possible to distil the normal paraffin  $C_{70}H_{142}$  but not  $C_{80}H_{162}$ .<sup>9</sup> The value for the heat of dissociation of the carbon-carbon bond (ca 75,000 cal.) lies between

<sup>6</sup> *Synthetic Organic Chemicals*, *loc. cit.*

<sup>7</sup> Freudenberg, Friederich and Bumann, *Ann.* 494: 57, 1932.

<sup>8</sup> Dunkel, *Zeits. physik. Chem.*, 138, 42, 1928; see also Meyer and Mark, "Der Aufbau der hochmolekularen organischen Naturstoffe," Akademische Verlagsgesellschaft, 1930, p. 23.

<sup>9</sup> Carothers and Hill, Kirby and Jacobson, *Jour. Am. Chem. Soc.*, 52: 5279, 1930.

the values of the molecular cohesions of these two compounds (70,880 and 77,220 cal., respectively).

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### AN INEXPENSIVE REDUCING LENS

THE appearance of a drawing, when reduced in size for publication, is frequently altered. A reducing lens is useful in determining the size of dots and the width of lines that will give the desired effect when the size of the drawing is decreased.

An ordinary microscope slide with concave depression serves nicely for this purpose. When the draw-

ing is viewed through the polished cavity in the slide it is reduced from one half to one third, depending upon the distance of the slide from the drawing. A further reduction may be had by placing two slides face to face so that their cavities coincide.

Culture slides with one polished concave depression, 15 or 16 mm in diameter by approximately 0.4 mm in depth, can be found in most biology laboratories, or may be had from the scientific companies for a few cents each. They make simple but effective reducing lenses.

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## SPECIAL ARTICLES

### THE FUNCTIONAL CHARACTERISTICS OF NINE RACES OF FIBROBLASTS

COMMON connective tissue cells, or fibroblasts, being the first to be isolated in pure cultures, have served as material for a vast array of studies from which much valuable information has been gained concerning the structural and functional properties of cells in general and of these cells in particular. For convenience, and in order that comparable results might be obtained by the various investigators, the material most generally used has been the original strain of fibroblasts isolated over 20 years ago, by Carrel, from the embryonic chick heart. Hence, the properties of these cells have become very well known. Some years ago, it was demonstrated, however, that functionally different cell strains, each of them possessing all the structural features commonly attributed to fibroblasts, could be isolated from various tissues of the same organism.<sup>1</sup> This disclosure, which resulted from a study of the diverse manner in which four different strains of fibroblasts reacted to a given nutritional régime, clearly indicated the error involved in confining classifications and definitions of cell types to purely morphological characters, without at the same time taking into account their physiological properties. It is believed that the additional information to be reported here will not only strengthen this view-point, but will also show the importance of enlisting as many of the characteristics of these cells as may be revealed, and of subjecting each to careful and systematic analysis, before attempting to explain the biological significance of any one of them.

Several series of experiments have recently been made in which a varying number of cell strains were isolated simultaneously from different tissues and organs of the same chick embryo and, from the very

beginning, subjected to conditions which were as identical as it was possible to make them. The procedures employed were the usual ones involving the flask techniques. Very soon after the tissues were removed from the organism, the cell population was rendered uniform by continued selection of only the marginal areas of outgrowth at the time of transfer. Then, by comparing these strains with one another, and with strains from similar series derived from embryos of the same age, it was possible to detect any outstanding properties manifested under the conditions of the experiment. The particular series that has been selected for the purpose of the present communication was composed of nine strains of fibroblasts isolated from a 17-day-old chick embryo and cultivated for ten passages (56 days) on a medium consisting of chick plasma, chick embryonic tissue juice and Tyrode solution. These strains were derived from the following tissues and organs: the wall of the dorsal aorta, the periosteum of bone, the perichondrium of cartilage, the wall of the ventricle, the wall of the proventriculus, the muscles of the lower limb, the kidney, the thyroid and the testis.

Aside from making a comparative study of the rate of growth of the various tissues over the entire period of cultivation, tests were carried out from time to time to determine the relative amount of free acid that accumulated in the medium. For this purpose, a dilute solution of phenol red was added to the medium of each flask, after which the hydrogen-ion concentration was adjusted by introducing into the flask a gas mixture of O<sub>2</sub>, CO<sub>2</sub> and N, these being combined in such proportions as to produce a temporary acidity of pH 7.8. The changes produced in the various cultures could then be read at 24 or 48 hour intervals by comparing them with a standard series of flasks of known pH values. Other experiments were designed to test the ability of the various races to sur-

<sup>1</sup> R. C. Parker, *Arch. f. exper. Zellforschung*, 8: 340, 1929.

vive and grow in an abnormally acid medium. This condition was also brought about by subjecting the cultures to an atmosphere composed of  $O_2$ ,  $CO_2$  and  $N$ , but this time the mixture contained a greater concentration of  $CO_2$  than that which had been used to establish a pH of 7.8. Thus it was found that the various tissues differed not only in their rate of growth and in the amount of acid that accumulated in the medium in which they were cultivated, but also in their ability to survive and grow in a medium in which the hydrogen-ion concentration was artificially increased. In addition, they showed marked variations in the extent to which they were able to digest fibrin. The accompanying diagram (Fig. 1) shows

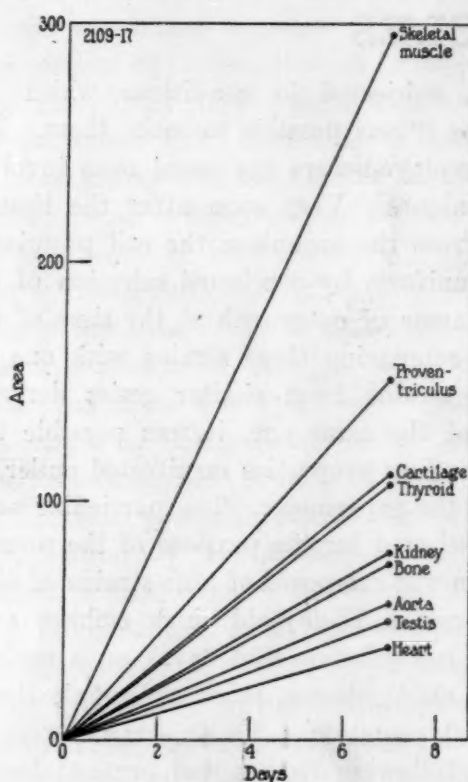


FIG. 1. Diagrammatic representation of the rate of growth of nine strains of fibroblasts isolated from a 17-year-old chick embryo and subjected to the same treatment from the beginning; 8th passage.

the relative growth rates displayed by these strains in their eighth passage. It will be seen that the fibroblasts derived from the heart muscle possessed the lowest growth energy of any of the series, whereas the fibroblasts from skeletal muscle showed the highest. In this respect, these two strains represented the extremes. Furthermore, these rapidly growing fibroblasts from skeletal muscle liberated a large amount of acid into the medium and were able to withstand a medium of high acidity. There was, however, very little digestion of fibrin. Fibroblasts from the proventriculus and the kidney, on the other hand, produced little acid, but rapidly digested the fibrin of the clot. The same was essentially true of fibroblasts derived from the thyroid, although in this case the

colonies grew extremely thin, much more so than has ever been observed for other races of fibroblasts. The fibroblasts from the aorta were characterized by a large production of acid. Although their rate of multiplication was much slower than that of fibroblasts from cartilage, thyroid, kidney or the proventriculus, they produced much more acid than any of these. In spite of this, however, they grew poorly in an acid medium.

These results indicate that the common connective tissue cell, or fibroblast, does not occur throughout the organism as a separate and distinct type. Fibroblasts as a group include many different cell types. Just, for example, as the *milieu intérieur* of the thyroid is different from that of the kidney, so also are the connective tissue cells which they harbor and nourish. Hence, it seems reasonable to assume that there are as many types of fibroblasts in the body as there are tissues and organs. These various cell types were originally endowed with identical properties and potencies by virtue of a common ancestry. But as they became integral parts of developing tissues and organs, they became more and more divergent, with the final result that, when separated from the organism, they retained those qualities that they had progressively acquired as an expression of the special localized conditions under which they had lived prior to their isolation.

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### BOOKS RECEIVED

- CARATHÉODORY, C. *Conformal Representation*. Pp. viii + 105. 44 figures. Cambridge University Press, Macmillan. \$2.25.
- CHAMBERLAIN, CHARLES J. *Methods in Plant Histology*. Fifth edition. Pp. xiv + 416. 139 figures. University of Chicago Press. \$3.25.
- Contributions to Embryology*. Pp. 267. Illustrated.
- Contributions to Paleontology*. Pp. 113. Illustrated.
- Carnegie Institution of Washington.
- DE SITTER, W. *Kosmos*. Pp. xii + 138. Illustrated. Harvard University Press. \$1.75.
- Forty-seventh Annual Report of the Bureau of American Ethnology, 1929-1930*. Pp. 1108. Illustrated. Smithsonian Institution.
- JAUNCEY, G. E. M. *Modern Physics*. Pp. xvii + 568. 213 figures. Van Nostrand. \$4.00.
- KELLS, LYMAN M. *Elementary Differential Equations*. Pp. ix + 184. 44 figures. McGraw-Hill. \$2.00.
- KNAGGS, I. E., B. KARLIK and C. F. ELAM. *Tables of Cubic Crystal Structure*. Pp. 90. Adam Hilger, London. 11/6d.
- MITCHELL, S. A. *Eclipses of the Sun*. Third edition. Pp. xvii + 490. Illustrated. Columbia University Press. \$5.00.
- Roosevelt Wild Life Annals*. Pp. 268-764. Illustrated. New York State College of Forestry.
- SMITH, ALPHEUS W. *The Elements of Physics*. Third edition. Pp. xviii + 778. 723 figures. McGraw-Hill. \$3.75.